ON THE AGE OF THE TEJON ROCKS OF CALIFORNIA, AND THE OCCURRENCE OF AMMONITIC REMAINS IN TERTIARY DEPOSITS.

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The controversy which for a long time was maintained between Conrad and Gabb as to the age of the Tejon rocks of California, referred by the former to the eocene series, and by the latter considered to represent the uppermost member of the cretaceous (Division B of the California Report), can scarcely be considered to have settled the question at issue.[1] Both paleontologists appear to have maintained their respective positions to the last, and to have permitted no considerations to outweigh the mass of proof that at the same time was bearing in both directions.[2] The essence of Conrad's views briefly stated is: That a portion of the rocks, that of Cañada de las Uvas, included in the cretaceous, fails "to show one cretaceous fossil," whereas, on the contrary, it is held to contain at least two representative, and at the same time highly characteric tertiary forms—"*Venericardia planicosta* and *Aturia zic-zac;*" and that, where in other deposits referred to the same horizon, an association between tertiary and cretaceous species obtains, such an association has been brought about as the result of the breaking up of the materials of an older formation, and the mixing up of their contained remains with those of a newer period. By Gabb, on the other hand, it is maintained that many of the forms referred to as tertiary species are in reality not such; that a repeated admixture between what have been considered to be strictly tertiary forms and cretaceous species manifests itself throughout the entire Californian (so-called) cretaceous series; and that no such breaking up and re-formation, as has been claimed by Conrad, are anywhere apparent.

[1] Conrad, Amer. Journ. of Conchology, I (1865), pp. 362–5; II (1866), pp. 97–100; Amer. Journ. of Science, new ser. XLIV (1867), pp. 376–7.
Gabb, Amer. Journ. of Conchology, II (1866), pp. 87–92; Amer. Journ. of Science, new ser. XLIV (1867), pp. 226–9; Proc. California Acad. Nat. Sciences, III (1867), pp. 301–6.

[2] The writer is informed by one who was intimately acquainted with both parties, that Conrad finally yielded his position, but he has been unable to discover the evidences of such a change of opinion in any of that author's writings.

The most elaborate defense of Gabb's position is that published in the "Proceedings" of the California Academy of Natural Sciences for 1867 (pp. 301–6), in a paper entitled "On the Subdivisions of the Cretaceous Formation in California." In this paper the author essays to show, by means of comparative tables, the close relation that exists between the faunal characters of the upper and lower members of his cretaceous group (Divisions B and A of the California Report), and to prove by this relationship the fallaciousness of a classification that would relegate the deposits of the group to two distinct eras in geological chronology. The following table of organic remains representing the fauna of the Tejon group (Division B), with the various localities of their occurrence, is there appended:[1]

	Upper Division (B)	Intermediate Beds.	Lower Divisions and Remarks.
Calianassa Stimpsonii,	C.T.		Chico.
Aturia Mathewsonii,	M.C.T.		Martiñez.
Nautilus Texanus,	C.		Shasta Co.
Ammonites, n. s.,	C.M.		Curry's; Benicia; Martiñez.
Typhis antiquus,	M.T.		
Fusus Martinez,	M.T.		
F. Mathewsonii,	M.C.		Curry's.
F. Diaboli,	C.		
F. aratus,	M.		
F. Californicus,	C.T.	LL.	
Hemifusus Hornii,	T.		
H. Cooperii,	C.D.		
H. Remondii,	M.C.T.G.		
? Neptunea supraplicata,	C.D.		
N. gracilis,	M.		
Perissolax brevirostris,		LL.	Many localities.
P. Blakei,	M.C.T.		
Turris Claytonensis,	C.T.		
T. raricostata,	C.		(*Varicostata* by error in [Rep.)
Cordiera microptygma,	T.		
Tritonium Hornii,	C.T.		

[1] A few species occurring in beds said to be intermediate between B and A, but not properly belonging to the Tejon Group, are here included. In addition to the 107 (112, inclusive of those from the "intermediate" beds) species enumerated in the list, a small number of other forms have been described in vol. II (1869) of the "Palæontology" of the California Survey. The different localities in the above table are designated by letters, as follows: M, Martiñez; C, Clayton to Marsh's, T, vicinity of Fort Tejon; G, a locality 10 miles west of Griswold's, near New Idria; I, New Idria; D, San Diego; LL, Lower Lake Village, 1 mile southeast of the town.

	Upper Division (B).	Intermediate Beds.	Lower Divisions and Remarks.
T. Diegoensis,	D.		
T. paucivaricatum,	T.		
T. Whitneyi,	T.D.		
Buccinum liratum,	M.	LL.	
Nassa cretacea,	M.T.G.		
Pseudoliva lineata,	M.		
P. volutæformis,	T.		
Olivella Mathewsonii,	M.T.G.C.		
Ancillaria elongata,	C.D.		
Fasciolaria læviuscula,	C.	LL.	
F. sinuata,	T.D.		
F. Io,	T.		
Mitra cretacea,	M.		
Whitneya ficus,	T.		
Ficus mamillatus,	T.		
Natica Uvasana,	T.		
Lunatia Shumardiana,		LL.	Martiñez and elsewhere.
L. Hornii,	T.		
L. nuciformis,	C. T.(D. ?)		
Gyrodes expansa,		LL.	Almost everywhere.
Neverita secta,	T.		
N., n. s.,	G.I.		
Naticina obliqua,	M.T.		
Amauropsis alveata,	M.C.T.G.D.	LL.	Curry's; S. of Mt. Diablo.
Morio tuberculatus,	M.T.C.G.D.		
Scalaria (Opalia) Mathewsonii	M.		
Niso polita,	M. T.		
Cerithiopsis alternata,	M.C.		
Architectonica cognata,	M.C.T.		
A. Hornii,	T.		
Margaritella crenulata,	D.		
Conus Remondii,	M.C.T.D.		
C. Hornii,	T.		
C. sinuatus,	T.		
Rimella canalifera,	M.T.		
R. simplex,	C.D.		
Aporrhais angulata,	M.		
Cypræa Bayerquei,	M.C.		
Turritella Uvasana,	M.C.T.G.		
T. Saffordii,		LL.	M. and Solano Co.
T. infragranulata,	M.		
Galerus excentricus,	M.C.T.D.I.	LL.	
Spirocrypta pileum,	T.I.	LL.	
Gadus pusillus,	M.T.		
Dentalium Cooperii,	M.D.		Curry's; S.of Mt. Diablo.
D. stramineum,	M.D.		Curry's; S.of Mt. Diablo.
Bulla Hornii,	T.		
Cylichna costata,	M.C.T.D.		M.; Texas Flat and many [other localities.
Megistostoma striata,	M.		
Martesia clausa,	G.		Pence's; Texas Flat, etc.
Solen parallelus,	M.C.T.		
Solena Diegoensis,	D.		
Corbula Hornii,	T.		

	Upper Division (B).	Intermediate Beds.	Lower Divisions and Remarks.
C. parilis,	G.M.D.		
Neæra dolabræformis,	M.		
Mactra Ashburnerii,	M.C.T.		Nearly everywhere in [both Divisions.
Gari texta,	M.		
Tellina longa,	M.C.T.		
T. Remondii,	C.T.		
T. Hoffmaniana,	G.		M.; Pence's, and else- [where.
T. Hornii,	T.		
T. Californica,	C.T.		
Meretrix Uvasana,	M.C.T.I.G.		
M. Hornii,	T. [D.		
M. ovalis,	T.		
Dosinia elevata,	T.		
D. gyrata,	M.C.T.G.		
Tapes Conradiana,	G.M.T.	LL.	
T. quadrata,	M.T.		
Cardium Cooperii,	M.T.D.		
C. Brewerii,	M.C.T.G.		
Cardita Hornii,	M.C.T.I.G.		
Lucina cumulata,	T.		
L. cretacea,	C.		
Mysia polita,	M.C.I.		
Crassatella grandis,	M.T.	LL.	
C. Uvasana,	T.		
Mytilus ascia,	T.		
Modiola ornata,	M.C.T.I.		
Septifer dichotomus,	T.		
Crenella concentrica,	M.		
Avicula pellucida,	M.G.	LL.	S. Louis Gonzaga.
Arca Hornii,	T.		
Cucullæa Mathewsonii,	C.	LL.	M.
Barbatia Morsei,	D.		
Axinæa sagittata,	M.T.G.		
A. Veatchii,		LL.	M.; Tuscan Springs, etc.
Nucula (Acila) truncata,	M.T.		Everywhere.
Leda protexta,	M.C.T.G.		M.
Placunanomia inornata,	D.		
Flabellum Remondianum,	C.		

Of the total number of 112 species here enumerated, 105 are recorded as being found in Division B (Tejon group), 15 in the so-called "intermediate beds," and 21 in various deposits of the lower group (Division A). The number of forms held in common by Divisions A and B, as is shown by the above table, and the intimate faunal relations which the "intermediate beds" hold to the deposits supposed to lie above and below them, it is claimed demonstrate conclusively that the series is a continuous one, and admits of no such separation as had been insisted upon by Conrad.

The value of a comparative table, such as is here presented,

naturally depends upon the accuracy of its details; whether in the present instance this accuracy is such as to entitle the table to special consideration, remains to be seen. On page 302 of the paper last referred to Mr. Gabb states: "Of 280 species of fossils recognized and named in the Californian cretaceous rocks, 107 are found in this upper member. Of these, 84 are peculiar, *and 23 are found in common between undoubted members of this group and undoubted members of the older group.*" The inaccuracy of this last assertion will be readily manifest when an appeal is made to the data afforded by the preceding table.[1] It will be seen that here only 16 species are enumerated whose range comprises the "undoubted members" of both the older and newer groups (A and B), as follows:

Callianassa Stimpsonii,	Cylichna costata,
Aturia Mathewsonii,	Martesia clausa,
Nautilus Texanus,	Mactra Ashburnerii,
Ammonites, n. s.,	Tellina Hoffmanniana,
Fusus Mathewsonii,	Avicula pellucida,
Amauropsis alveata,	Cucullæa Mathewsonii,
Dentalium Cooperii,	Nucula (Acila) truncata,
D. stramineum,	Leda protexta.

But in glancing over the original descriptions of the species here cited, as given in vol. I of the Palæontological Report, and the more recent list of distribution published in vol. II, we find—

1. Vol. I, p. 59, that all the specimens (4) of *Nautilus Texanus* were obtained from Division A (older group), no reference being there made of its occurrence in any deposit of newer date; nor is any mention of the species being found in Division B made in the more recent list of distribution (p. 209) contained in vol. II of the Report (1869). In vol. II of the "American Journal of Conchology" (p. 88) the species is quoted from Clayton (B), but Mr. Gabb has here evidently confounded the name of a finder ("the last was found by Mr. Clayton") with that of the locality.

[1] Mr. Gabb has here evidently included the "intermediate beds" among the "undoubted members of the older group," and yet to disclaim any intention on his part for so doing, he adds (immediately following the sentence above quoted): "Besides this, I was fortunate enough to discover a locality near Clear Lake, this fall, where, within a space of two feet, I found an admixture of upper and lower forms, proving the existence of a transitionary bed, or, perhaps, group of beds." In justice to Mr. Gabb, it must be stated, that on p. 305 of the same paper, only 16 species, a figure more nearly the correct one, are stated to be common to Divisions A and B.

2. Vol. I, p. 195, no indication is given of the occurrence of *Cucullæa Mathewsonii* in deposits belonging to Division B, although the locality Martiñez, where beds representing both B and A are to be met with, is given. From this indefinite statement it might be inferred that the specimens were obtained from the upper beds, but any doubt on this point is set at rest by the subsequent reference (Amer. Journ. Conchol. II, p. 88; Cal. Pal. Rept., II, p. 249) of these Martiñez beds to the Martiñez group (A). The second locality given (for a single specimen) is "Clayton, *below*[1] the coal-veins," which in vol. II of the Report (*loc. cit.*) is referred to the "intermediate beds."

So that deducting these two forms which have not yet been detected in the deposits of Division B, these last have at the utmost (at least as far as is known), only 14 species common to the lower Division (A), instead of 23 as claimed.

But while 14 species *may* actually be held in common by the upper and lower members, we are far from satisfied that such really *is* the case. Thus Mr. Gabb states (Pal. Report, I, p. 153) that *Mactra Ashburnerii* "is one of the most common fossils in the State," and instances numerous localities of its occurrence in both divisions A and B; and further (in Am. J. Conchol., II, p. 88), that it is found in "almost every locality of both Divisions." It would certainly be a difficult matter to disprove such an affirmation, but it is, to say the least, surprising, that a careful examination of all the specimens of the Gabb collection in the possession of the Academy of Natural Sciences, which have served as the basis of the Palæontological Report, and which comprise probably the greater number, if not nearly all, of the cretaceous "types" and figured specimens, we have failed to discover a single fragment from Division A. (Martiñez, Chico, and Shasta groups) that could with any amount of positiveness, or with anything more than considerable doubt, be referred to the form that under the same name is credited to Division B (Tejon group). This is the more singular since the collection embraces a very considerable number of rock fragments, which are crowded with molluscan remains. Two specimens marked in Gabb's handwriting as coming from Texas Flat (Chico group, A), and considered by that paleontologist to represent the "typical form."

[1] The italics appearing in the quotations belong to the writer of this article.

(so marked) of the species, differ very essentially in outline from the Tejon specimens, and are doubtless specifically distinct. Again, in the case of *Nucula truncata* Mr. Gabb instances (Pal. Rept., I, p. 199) several localities of its occurrence in Division A, and also Martiñez as a locality of Division B, but no mention is made of the last named as a locality of the first Division. On the other hand, *all the Martiñez specimens of this species in the Gabb collection are marked as belonging to Division A!* In vol. II (p. 197) of the Reports, however, we are informed that this species is " found at almost every locality of the Chico, Martiñez, and Tajon groups," but we must confess that, after a diligent search, we have failed to discover among the Tejon rock fragments anything that could with sufficient evidence be referred to this form. Nor have we been able to find the faintest traces of *Leda Gabbii* (*protexta* of Gabb) (or for that matter, of several other forms belonging to group B) in the rock fragments obtained from the older members, but it would perhaps be premature to conclude from this that it may not really occur there. On page 199 of vol. I, the only locality given for Division A is (near) Martiñez (at the same time a locality for Division B), but in the " tabular statement " appended to the same volume (p. 235) the ranch of San Luis Gonzaga is substituted instead. *Tellina Hoffmanniana* is not stated in the original description (vol. I, p. 156) to be found in any locality of Division B, nor is it included in the list of " common " species given in 1866 in the American Journal of Conchology (11, p. 88). In vol. II of the Reports, however (p. 182), this species, which could originally " always be distinguished by its straight or slightly convex cardinal margins," but which has now become a " rather variable " form, is reported from two localities (Martiñez and " Griswold's ") of the Tejon group. An inspection of Mr. Gabb's figures (I, pl. 22, figs. 33, 33a; II, pl. 30, fig. 72) will, we believe, fail to convince one that in both instances the same species is represented, and, indeed, in the Martiñez (B) specimens the " straight or slightly convex cardinal margins " characteristic of the species have become both anteriorly and posteriorly *decidedly* convex.

Mr. Gabb invokes the assistance of his " intermediate beds," unknown to him at the time of the publication of the first volume of his Reports, to prove the intimate relation that exists between the upper and lower members of his cretaceous series. An ex-

amination of the preceding table will show that 7 species, not found in deposits older than the intermediate beds, are credited as being common to these last and the Tejon group, as follows :—

Fusus Californicus,	Spirocrypta pileum,
Buccinum liratum,	Tapes Conradiana,
Fasciolaria læviuscula,	Crassatella grandis.
Galerus excentricus,	

These are said to be associated with a limited number of forms that are found in the lower division, but which do not pass above, and (if we except *Cucullæa Mathewsonii*, which has been shown *not* to belong to the upper member) with only one *solitary* form, *Avicula pellucida*, that is common to both divisions, a circumstance of suspicious import. But in turning to the original description of *Fasciolaria læviuscula* (vol. I, p. 101) we find no mention of its being found in deposits belonging to Division B, but on the contrary, it is distinctly stated to have been "found in the strata immediately *below* the coal in the Mount Diablo district" (although it was *associated* with several species found also at San Diego and Martiñez of Division B), and in vol. II of the Report (p. 220), *only* the "beds intermediate between the Martinez and Tejon groups" are given as the locality of its occurrence. Nor do we find in the lists of distribution contained in vol. II[1] any mention of the "intermediate beds" in the case either of *Buccinum* (*Brachysphingus*) *liratum*, *Galerus excentricus*, or *Spirocrypta pileum*, although it does occur in the case of the remaining three (*Fusus Californicus*, *Tapes Conradiana*, and *Crassatella grandis*).

We believe it may be fairly questioned, from what has already been shown, whether Mr. Gabb's tables afford *at all* a safe criterion upon which to base the solution of the problem at issue. The numerous discrepancies would seem to prove almost conclusively that in their preparation the author was in a measure, or even to considerable part, borrowing from his memory, or, at any rate, not absolutely from the data that were presented in the field. But granting that the tables be entirely trustworthy in the statements that have been called into account, do they at all prove his case?

[1] Published more than one year *after* the paper in the "Proceedings of the California Academy, and therefore at a time when Mr. Gabb ought to have been fully cognizant of the value and position of his intermediate beds.

We believe most assuredly not. Surely a geologist would find it difficult, on the assumption of immediate continuity and without the assistance of a change in the general character (whether marine, fluviatile, or terrestrial) of the fauna, to account for the rather anomalous circumstance, that, in a locality rich in organic remains, the upper member of a closely connected series should be characterized by a fauna about 80 per cent.[1] of whose individual forms is peculiar to itself. In order to antagonize this difficulty, and, at the same time, to show still more effectively how much more closely the members of this upper group of deposits are linked to the beds below them (and, consequently, how indisputably cretaceous) than to those following (and, therefore, how little tertiary), Mr. Gabb submits the argument (Proc. Cal. Acad. Nat. Sciences, 1867, p. 306 ; A. J. Science, new ser., vol. XLIV, p. 229), that "All of the species are peculiar to this group (B), or to this and *underlying*[2] rocks ; *not one* has been found associated either with living forms, or with species known to occur in the recognized tertiaries of California. Five of the genera are peculiar to the secondary. An Ammonite ranges entirely through the group to the top of the highest fossiliferous strata. The genera *Perissolax*, *Gyrodes*, *Margaritella*, and the sub-genus *Anchura*, of the genus *Aporrhais*, are all recognized as strictly characteristic of the cretaceous; so much so, that the presence of a single undoubted representative of either of these genera would be strong presumptive evidence of the cretaceous age of any rocks in which it might be found." But Mr. Gabb omits to emphasize in this connection (although a casual reference to a part of the facts is made), and as directly bearing upon the subject of chronological relationship, the *first* appearance (in California) in the deposits of this group of the genera (among others) *Ancillaria*, *Bulla*, *Conus*, *Cypræa*, *Crepidula* (*Spirocrypta*), *Cassidaria* (*Morio*), *Ficus*, *Gadus*, *Mitra*, *Nassa*, *Niso*, *Olivella* (*or Oliva*), *Pseudoliva*, *Rimella*, *Triton*, *Trochita*, *and Typhis*, many of them distinctively, and as has been generally recognized *exclusively* tertiary forms. Nor does that paleontologist appear to lay the least stress upon, or even advert to the circumstance that the eminently mesozoic genera *Ancyloceras*, *Hamites*, *Helicoceras*,

[1] The percentage takes into account the full number of forms said to be held in common by the upper member and the intermediate beds.

[2] The italics are Gabb's.

Turrilites, *Crioceras*, *?Ptychoceras* (*Helicancylus*), *Baculites*, *Inoceramus*, *Trigonia*, *Gryphæa*, and *Exogyra*, which are found in one or other, or several of the deposits of the older group (A), are here completely wanting. Surely the wholesale appearance and disappearance of characteristic genera have *at least* as much import in the determination of geological chronology, or in the fixing of systemic relationships, as the casual persistence of a few specific types, and, indeed, a paleontologist or zoologist would be very bold to assert that the distinctive characters of a fauna depend rather upon the features drawn from its specific, than from its generic constituents.[1] It would appear strange, to say the least, if a geologist were now to unite the Devonian and carboniferous formations, or the Silurian and Devonian, for no other reason than that they comprise in their several faunas a number of "common" forms, when the general facies of these faunas is very distinct.[2]

[1] Accepting the generic determinations of Mr. Gabb, we find that of about 77 genera credited as belonging to the Tejon group, no less than 33 (or 43 per cent.) have *not* been described from the cretaceous deposits underlying this group; and 3 additional ones do not pass beyond the "intermediate beds!" The faunas are here, then, decidedly *very* distinct, despite the fact that a limited number of "common" or passage forms (forming at the utmost only about 13 per cent. of the Tejon fauna) may be said to exist.

[2] According to Etheridge (Anniversary Address, London Geol. Soc., 1881—Quart. Journ. Geol. Soc., pp. 184–185), of 37 species of brachiopods occurring in the upper British Devonian, 16 pass into the succeeding carboniferous deposits; these last also hold 5 species of upper Devonian lamellibranchs, 5 gasteropods, 2 heteropods, and 4 species of the genus *Orthoceras*. Of the total number of 183 genera and 526 species constituting the British Devonian fauna, 30 genera and 49 species pass into the carboniferous (*loc. cit.*, p. 197). In California, of about 141 genera described from Division A (Martiñez, Chico, and Shasta groups), 44 are also found in Division B (Tejon group), and, therefore, the proportion of generic forms common to what is here claimed to be both cretaceous and tertiary is greater than that which obtains in the case of the British Devonian and carboniferous formations. But if in both instances only the molluscan fauna (which comprises, with the exception of 5 species, all of Gabb's described forms) is taken into account, a very striking correspondence in the numerical proportions presents itself. Thus, according to Etheridge's tables, 25 out of the 74 Devonian molluscan genera appear in the carboniferous deposits, or nearly 34 per cent.; in California, 40 of the 133 Division A genera are also represented in Division B, or 30 per cent. According to

But it is here maintained, that in addition to a purely specific relationship we have one established through generic ties. "An Ammonite ranges entirely through the group to the top of the highest fossiliferous strata. The genera *Perissolax*, *Gyrodes*, *Margaritella*, and the sub-genus *Anchura*, of the genus *Aporrhais*, are all recognized as strictly characteristic of the cretaceous; so much so, that the presence of a single undoubted representative of either of these genera would be strong presumptive evidence of the cretaceous age of any rocks in which it might be found" (Proc. Cal. Acad., p. 306). Laying aside for the present the question of the Ammonite, only a few words need be said respecting the other genera.[1] As Mr. Conrad has already shown (A. J. Science, new ser., xliv, p. 376), no locality in Division B is assigned to the (2) species of *Gyrodes* in vol. i, of the report, but on the contrary, both are clearly assigned to the Division A; and

Mr. Etheridge (*loc. cit.*, p. 179), 12 genera (of 137), and 20 species (of 392), of Ludlow (upper Silurian) fossils pass into the Devonian; and 11 genera (of 61), and 16 species (of 182) from the Cambrian into the Silurian (Arenig) (p. 100).—The circumstance that the faunal break between the cretaceous and tertiary periods is in all, or nearly all, localities thus far studied greater than between the Devonian and carboniferous or the Silurian and Devonian, has no bearing on the point at issue, since a connection or passage must exist somewhere, and it is quite immaterial where this passage may be found. The assertion that has at various times been repeated that no cretaceous species have been known to pass beyond the limits of that period, has been definitely refuted by comparisons made between the foraminiferal faunas of chalk and the Atlantic ooze, and, doubtless, impartial examination will reveal a number of higher forms in post-cretaceous deposits, undistinguishable from forms which have up till now been considered to characterize strata of more ancient date. It would probably puzzle many paleontologists to determine by what special characters certain cephalopods (*Nautilus*) or brachiopods of tertiary, or for that matter, of recent age, are distinguished from their more ancient congeners, and, indeed, even such a high authority as Mr. Davidson ("British Tertiary Brachiopoda," p. 14, Palæont. Soc. Repts., 1852), has found it difficult to differ from the opinion expressed by Edward Forbes that at least one existing brachiopod (*Terebratulina caput serpentis*) is also a cretaceous form.

[1] Although in the text it is not *absolutely* stated that these several genera all occur in the rocks of the Tejon group (but "in this and associated rocks"), the connection in which the statement is made would seem to imply that they did so occur; and Mr. Gabb's inference would certainly justify such an interpretation of the statement.

in vol. ii (p. 222) the transition beds are given as the upper limit of the genus. In the case of the genus (or sub-genus) *Anchura*, the species especially referred to, *A.* (*Aporrhais*) *angulata*, is stated (vol. i, p. 128) to occur very sparingly near Martiñez "in a single stratum of greenish-gray limestone," and is credited *exclusively* to Division B; yet, in the same description, a locality in Division A—Cottonwood Creek, Shasta County—is mentioned! Furthermore, in the "tabular statement" appended to the same volume (p. 227), the Martiñez locality of the identical species is referred to Division A! In vol. ii (p. 226), while the localities are given, the group has been wisely omitted. As to the forms that have been referred to *Perissolax*, it would be very difficult to state why they should be considered as being characteristically cretaceous. It is true that the genus was founded on cretaceous species,[1] but it would be, indeed, a very comprehensive genus that would embrace such entirely dissimilar forms as the *Pyrula* (*Fusus*) *longirostra* of D'Orbigny,[2] one of the types of the genus, and the *P. Blakei* (*Busycon? Blakei* of Conrad) and *P. brevirostris* that are here referred to it (and also the *Fusus Durvillei* and *F. Hombroniana!*).[3] There is, as far as we are aware, not the faintest reason for considering the California species here indicated as representing cretaceous molluscan types, whatever may be thought of the genus *Perissolax* as originally founded; on the contrary, as Conrad has pointed out (A. J. Science, new ser., xliv, p. 376), they more properly belong to his genus *Levifusus* (sub-genus? of *Fusus*), represented in the eocene of Alabama by the *Fusus trabeatus* (*F. bicarinatus* of Lea, young).

Respecting the forms that have been referred to *Margaritella*, and to their being "strictly characteristic of the cretaceous," it need only be stated that Mr. Meek, the author of the aforesaid

[1] Gabb, Proc. Am. Philos. Soc., 1861, p. 66.

[2] *Paléont. de l'Amér. mér.*, p. 119, pl. 12, fig. 13.

[3] D'Orbigny, *Voyage de l'Astrolabe et de la Zélée*, pl. 2, fig. 1, and pl. 1, fig. 31. . . . Gabb, Proc. Amer. Philos. Soc., 1861, p. 67. It can scarcely be wondered at that neither Conrad nor Stoliczka could grasp the characters of the genus, and that the latter referred the typical form not only to a distinct genus, but to a very different family, the *Purpuridæ* (Palæontologia Indica, Cretaceous Fauna, II, p. 149).

genus, distinctly affirms[1] that they do *not* belong where they have been placed, but in the genus *Solariella* of Wood, which was founded on a tertiary (pliocene) fossil, *S.* (*Margarita?*) *maculata* from the British Coralline Crag.[2]

So far, therefore, not one of Gabb's characteristic cretaceous genera, with the exception of the Ammonite, of which several specimens are said to have been found in the rocks of the Tejon group (and of which, or of an allied genus of the *Ammonitidæ*,[3] the author of this article was fortunate enough to discover a solitary fragment), carries out the inference that has been drawn from their actual or supposed existence.

Having thus, as we believe, satisfactorily shown the erroneousness of many or most of the data that have served as a guide in the classification of the rocks in question, and to their reference to the cretaceous period, it now remains to examine in greater detail the reasons why these should be considered as *not* cretaceous, but tertiary. Briefly repeating what has already been said, we find that the Tejon fauna (considered solely with respect to the other California faunas) comprises about (and *probably considerably more than*) 80 per cent. of forms peculiar to itself, or at least that are not found in deposits representing a lower horizon; that 33 out of its 77 genera, constituting 43 per cent. of the entire number, are likewise not represented in the older deposits; that with the exception of a few fragments or specimens (about 7 in all) of one or two forms of *Ammonitidæ*, there is a complete absence of distinctively cretaceous organic types (while they are sufficiently plentiful in the subjacent beds); and finally, that there is a sudden introduction of new molluscan types, most of which are but barely, if at all represented in the cretaceous deposits of the world (as far as has yet been determined), and several of which are not known to have preceded the tertiary period. The appearance here for the first time of the genera *Ancillaria*, *Bulla*, *Conus*, *Crepidula*, *Cassidaria*, *Cypræa*, *Ficus*, *Gadus*, *Mitra*, *Nassa*, *Niso*, *Olivella* (or *Oliva*), *Pseudoliva*, *Rimella*, *Triton*, *Trochita*,

[1] U. S. Geol. Survey of the Territories, ix, Invertebrate Palæontology, pp. 301–2, 1876.

[2] Catalogue of Crag Mollusca, Ann. Mag. Nat. Hist., ix, 1842, p. 531; "British Crag Mollusca" (Palæont. Soc. Rep., 1848), i, p. 134.

[3] The fragment was too imperfect to admit of positive generic determination.

and *Typhis*[1] has already been adverted to. But these are not the

[1] The writer is unaware that any unequivocal species of the genera *Ficus* (*Sycotypus*; *Pyrula*, as restricted), *Gadus*, *Nassa*, *Niso*, *Olivella* (or *Oliva*), *Rimella*, or *Typhis*, have been described from deposits antedating the tertiary.

Pyrula Pondicherriensis of Forbes (Trans. Lond. Geol. Soc., vii, p. 127, 1846; *Pyrula Carolina* of D'Orbigny, Voy. Astrolabe et Zélée, Pal. pl. 11, figs. 34 and 35), a ficuliform species from the cretaceous deposits of India, has been shown by Stoliczka to belong to the *Volutidæ*, and to a new genus, *Ficulopsis* (Pal. Indica, Cretac. Fauna, ii, pp. 84–5).

Nassa lineata of Sowerby (Fitton's Report, Trans. Lond. Geol. Soc., 2d ser., iv, p. 344, pl. xviii, p. 25), from the Blackdown sands, may be a true member of the genus to which it is referred, but neither the figure nor description of the species permits of such a determination. The second species described in the same report, *N. costellata*, has been referred by D'Orbigny, Pictet, and Stoliczka to *Cerithium*. The first of these is the only cretaceous species recognized by Pictet and Campiche (*Materiaux p. l. Paléont. Suisse*, iii ser., p. 673) as being probably a *Nassa*, but the author's conclusions on this point appear to have been based entirely upon Sowerby's original determination. Stoliczka (*op. cit.*, p. 143) places *Buccinum Steiningeri* of Müller (*Petr. Aach. Kreidef.*, p. 78, 1851), an unfigured species from the chalk of Aix-la-Chapelle, in *Nassa*, but on what authority or for what reasons, this reference is made, we have found it impossible to discover. The two species of *Nassa* described by the last named author from the cretaceous Arrialoor group of India, *N. Vylapaudensis* and *N. Arrialoorensis*, and determined from imperfect specimens, are at best but very doubtful, and, indeed, it is stated that the last may possibly be a *Mangelia* or *Defrancia* (*op. cit.*, p. 145)!

Niso Nerea of Deslongchamps (*Bull. Soc. Linn. Norm.*, 1860, v. p. 126; *Turbo Nerea* of D'Orbigny, *Pal. Franc. Terr. Jur.*, pl. CCCXXVI, figs. 4 and 5) considered by Stoliczka (op. cit., p. 288) to be possibly referable to one of the subgenera of *Niso*, does not appear to have much, if anything, in common with that genus; nor can much more be said in favor of the other species (*Turbo*, *Trochus*, etc.) referred by Deslongchamps to the same genus.

Oliva vetusta of Forbes (Trans. Lond. Geol. Soc., 2d ser., VII, p. 134, pl. 12, fig. 23), from the cretaceous rocks of Southern India, is a *Dipsacus* according to Stoliczka (Pal. Indica, Cret. Fauna, II, p. 452, pl. XXVIII, fig. 27). The *Oliva? prisca* of Binkhorst (*Monogr. Gastr. et Ceph. Craie sup. de Limbourg*, 1861, p. 71, pl. Va², fig. 14) is unrecognizable as a member of the genus to which it is referred, and, according to the author himself, may possibly be a fragment of a *Cyprœa*.

Of the genera *Pseudoliva* and *Ancillaria* it would appear that only a single cretaceous species of each has thus far been recognized; the *P. subcostata* of Stoliczka (*op. cit.*, p. 145) (from the Arrialoor group of Southern India), described from a solitary imperfect specimen, and the *A.*

only more or less strictly tertiary genera that are here represented. In the *Tritonium paucivaricatum* (Palæont. Calif., I, p. 95, figs. 209, 209a, very badly figured) we have a true *Cancellaria!* The *Megistostoma* (new genus[1]) *striata* (I, p. 144) is a true *Bullæa*, a genus represented by a very limited number of fossil forms, and so far not known to have appeared before the tertiary period. *Naticina obliqua* (I, p. 109) appears more like a *Sigaretus*, the shell (in the specimens examined, all of which are partially imbedded in the matrix) being considerably more depressed than in the genus *Naticina*. But to whichever of these two genera the species may belong, it is immaterial in the present consideration, since no unequivocal member of either form, as far as the writer is aware, has been described from any formation older than the tertiary.[2] In vol. II of the Report (p. 157) we have described a member of the genus *Bullia* (sub-genus *Molopo-*

cretacea of Müller (*Monogr. Petr. Aach. Kreidef.*, p. 79, pl. 6, fig. 23), from the chalk of Aix-la-Chapelle, and described from a single imperfect impression. The least equivocal of the several doubtful cretaceous forms that have been referred to the genus *Conus* is probably the *C. Marticensis* of Matheron (*Cat. des Corps organisés fossiles, Bouches-du-Rhone*, 1842, p. 257. pl. 40, figs. 24–25), from the chalk of Martigues. There seems to be no reason for specially doubting that the imperfect specimen here figured is a true cone, but yet it would be by no means surprising if closer examination would prove it to be a form more closely related to *Acteonella* or *Acteonina*. The *C. tuberculatus* of Dujardin (*Mém. Soc. Geól. de France*, 1835, II, p. 232, pl. XVII, fig. 11), from the chalk of Tours, is not unlikely, according to Stoliczka (*op. sit.*, p. 72), to be a member of the cretaceous genus *Gosavia*, which it resembles (differing from all other true cones) in its ornamentation. *Conus canalis* of Conrad (Journ. Phila. Acad. Nat. Sciences, 2d ser., III, p. 321, pl. 35, fig. 22), from the "Ripley" group of Mississippi, scarcely admits of positive generic determination. *Conus gyratus* of Morton, (Syn. Org. Remains, Cretac. group, 1834, p. 49, pl. X, fig. 13), from the white limestone of South Carolina, is an eocene species.

[1] The distinctive characters of this supposed new genus, as pointed out by Gabb, are more imaginary than real.

[2] *Natica acutimargo* of Rœmer (*Verstein. Nordd. Kreidegeb.*, 1841, p. 83, pl. XII, figs. 14, a, b), from the chalk-marl of Quedlinburg and Dülmen, and said to have fine revolving lines, may possibly prove to be a *Sigaretus*, but the sutural canaliculation would seem to render this point rather suspicious. *Sigaretus Pidanceti* of Coquand (*Mém. de la Soc. d'émul. du Doubs*, 2me sér., VII, p. 46, pl. 5, figs. 4 and 5, 1856) is a *Natica* according to Pictet and Campiche (*Mat. Paléont, Suisse*, 3me sér., p. 380, pl. LXXVI, fig. 1, a, b, c.)

phorus, doubtfully different from the tertiary and recent genus, or sub-genus, *Buccinanops*); and finally (*Ibid.*, p. 162), a *Terebra* (*T. Californica*), a genus whose range has not yet positively been determined to extend back beyond the limits of the Tertiary period.

So that of the 77 genera represented in the Tejon group, at the very least 22 are more or less distinctively[1] tertiary; and of these 22, 11 are not positively known to have appeared before that epoch of geological time. On the other hand, if we except the six or seven fragments of *Ammonitidæ* (one, or possibly two genera) already referred to, there would seem to be in the entire number *not a single distinctively cretaceous generic type!*

Evidence Afforded by Specific Forms.

The circumstance, considering the deposits here referred to to be eocene, that "not one [species] has been found associated either with living forms, or with species known to occur in the recognized tertiaries [miocene and pliocene] of California" (Gabb, Proc. Calif. Acad. Nat. Sciences, 1867, p. 306), is not very surprising. The number of species that pass from the deposits of eocene age into the miocene is frequently very limited, or there may not be a single one. This last is, singularly enough, what obtains in the case of the tertiaries of the eastern and southern United Stated, where both the eocene and miocene formations are extensively developed, and where the organic remains are also very abundant.[2]

Leaving aside the question of identity as existing between the eocene and miocene forms, it will be important to ascertain what correspondence, if any, manifests itself between the specific types of the deposits here discussed, and those of other tertiary (eocene) localities; for the determination of this point we subjoin the following notes on a few of the species:

Cardita Hornii and Cardita planicosta.—Whether the species of *Cardita* described by Conrad from the rock of Cañada de las Uvas as *C. planicosta* (Pacific R. R. Reports, V, p. 321), and designated by him as the "finger post of the eocene" (*Ibid.*, p. 318), is the veritable *C. planicosta* of Lamarck, or not, it is impossible to state. The author's intimate acquaintance with that species, from both European and American

[1] But sparsely, if at all, indicated in the earlier deposits.

[2] It would be, perhaps, going too far to state, that not a single species is held in common by these eocene and miocene deposits; it would be more proper to say, that none such has yet been recognized.

forms, ought certainly to have enabled him, in the presence of fairly preserved specimens, to determine this point definitely, but whether the specimens in question were actually in a condition to admit of such positive determination, can, at the present time, only be conjectured. The description accords well with the species (and in a measure, also, the figure), but it is a little too brief to admit of a positive conclusion being drawn therefrom. For a similar reason it would be impossible to affirm conclusively whether the species is, or is not the *C. Hornii* of Gabb (Palæont. Calif., I, p. 174; II, p. 188), specimens of which were found near the same locality. I believe there can be no doubt that the character pointed out by Gabb (II, p. 188), as distinguishing the two species here mentioned—namely, the form of the ribs, which are rounded in the one (*C. Hornii*), and flattened in the other (*C. planicosta*)—has a certain value, but whether sufficient to permit of specific distinctions being based upon it in the absence of all other characters, can only be determined when a greater number of perfect specimens will have been brought together for comparison. In all other respects the two species appear to be identical, as will be seen from the following (Gabb's) statement: "I have compared my specimens with shells from the London clay, and from the Alabama eocene, and find that, except in the extreme quadrate forms,[1] they are absolutely identical in all characters save one. The hinges are so similar that I despair of making an intelligible written description of their minute differences, and should hardly feel willing to trust an artist with their delineation." Granting the specific value of the character claimed by the aforesaid paleontologist, the type (*C. Hornii*) still remains distinctively tertiary,[2] since what may be considered as analogous forms, are to the knowledge of the writer, completely wanting (although the genus is already represented) in the pre-tertiary deposits.

Dosinia elevata (I, p. 167) is more likely, as stated by Conrad, to be a *Dosiniopsis* than *Dosinia* (Am. J. Conchol., II, p. 98), despite the assurances of Mr. Gabb to the contrary (*Ibid.*, p. 91).[3] As much as can be determined from the figured specimen it appears to be very closely allied to the *Dosiniopsis Meekii* of Conrad (*Cytherea lenticularis?* of Rogers), from the lower eocene of Maryland and Virginia, from which it mainly (or barely) differs in the greater width of the flattened area on the posterior slope.

Meretrix Hornii (I, p. 64; II, pl. 30, fig. 78), a form allied to, but not as produced posteriorly as the *Cytherea suberycinoides* of the Paris basins.

Ficopsis (Hemifusus) Rémondii (I, p. 87, pl. 18, fig. 36), a form very closely related to, if not identical with the *Pyrula penita* of Conrad (= *P. nexilis* and *P. tricarinata* of Lamarck), from the eocene of Claiborne, Ala. The occasional tricarination observable in that form, as well as in its European representative, is here also apparent. The only difference of any account we could detect between the two species is that in the Californian form the surface reticulation is somewhat the finer, but since there is no exact constancy in the order of this reticulation, it may be doubted whether the difference here noted is of more than varietal value.

[1] . . . though some specimens, four and four and a half inches across, are as distinctly triangular as the typical *planicosta*" (II, p. 188).

[2] The character of the ribs, previous to weathering, is very much as in the *C. pectuncularis* or the *C. Jouanneti.*

[3] No perfect hinge is exhibited in any of the specimens of the Gabb collection, which includes the figured form.

Tritonium paucivaricatum (I, p. 95, pl. 28, figs. 209, 209a, unrecognizably figured), as has already been stated, is a *Cancellaria*, and a form so closely related to the *C. evulsa*[1] of Brander ("Fossilia Hantoniensia," 1766, p. 14, as *Buccinum*; pl. 1, fig. 14), from the British Bartonian (upper eocene), that it may well be doubted whether it is at all specifically distinct; and the same may be said of its relation to a form[2] from the lower eocene deposits of Clarke County, Ala., which is doubtfully referable to the *C. tortiplica* of Conrad.

Megistostoma striata (I, p. 144, pl. 21, figs. 108a, b).—While, perhaps, from the slightly imperfect condition of the specimen, it would be impossible to affirm positively that this species is identical with the *Bullæa expansa* of Dixon, from the eocene of Brackelsham, England, and the Paris basin (Deshayes, *Animaux sans Vertebres, Bassin de Paris*, II, p. 652, pl. 36, figs. 27–30, *Mollusques Cephales*), yet, what there is of it shows absolutely no character by which to distinguish it from that species.

Conclusion.

We believe it has been satisfactorily shown from what has preceded, that the rocks of the Tejon group (cretaceous Div. B. of the California survey), despite their comprising in their contained faunas a limited number of forms[3] from the subjacent

[1] Compared with actual specimens.

[2] Kindly transmitted for examination, with other fossils, by Dr. Eugene A. Smith, State Geologist of Alabama.

[3] The reliance that is to be placed upon Gabb's *positive* assertions as to the localities or horizons whence certain species have been obtained, may be inferred from the statement (Am. Journ. Conchology, 1866, II, p. 90), that *Naticina obliqua* and *Turritella Uvasana*, species claimed to be eocene by Conrad, were "found by Mr. Rémond and myself in strata containing *Ammonites* and *Baculites*, and abounding in other cretaceous forms." A reference to the descriptions of these two species, as well as to the various tables of distribution published (before and after the making of the statement) by Gabb, clearly shows that the forms in question were *not* known to that paleontologist to pass beyond the limits of Division B. How then could they be associated with the *Baculites*, when the only Californian species of that genus, *B. Chicoensis*, is distinctly stated (I, p. 81) to be "only found in Div. A"? So likewise from the statement (Am. Journ. Conchology, II, p. 89), that *? Ammonites Cooperii*," one of the *Ammonitidæ*, whether an *Ammonite* or not, is from the presumed eocene of Mr. Conrad, from San Diego, and the family is sufficient to establish the age of that deposit, had we no other proof." But singularly enough, in the description of this ammonitic fragment (I, p. 70), the specimen is said to be "of particular interest from the fact that it is *one of the oldest* fossils found in the southern part of the State, being *considerably below* the newer cretaceous fossils of San Diego!" (The italics belong to the writer of this article). And in vol. II (p. 212) the species is doubtfully referred to the Chico group!

(cretaceous) deposits, and a few undoubted representatives of the *Ammonitidæ*, are of tertiary (eocene) age, and for the following reasons:

I. The large percentage (about 80, or possibly considerable more) of specific forms that are peculiar to the group, or, at least are not found in the older deposits;

II. The large proportion of generic forms (33 out of 77) that are not represented in the underlying or older strata;

III. The presence of 22 more or less distinctively tertiary genera: *Ancillaria*, *Bulla*, *Bullæa* (*Megistostoma*), *Bullia* (s. g. *Molopophorus*) *Conus*, *Crepidula*, *Cassidaria*, *Cancellaria*, *Cypræa*, *Ficus* (*Ficopsis*), *Gadus*, *Mitra*, *Nassa*, *Niso*, *Olivella* (or *Oliva*), *Pseudoliva*, *Rimella*, *Sigaretus* (or *Naticina*), *Terebra*, *Triton*, *Trochita*, and *Typhis;*

IV. The marked absence (with the exception of about a half-a-dozen fragments or specimens of *Ammonitidæ*) of distinctively cretaceous organic types;

V. The identity, or very close analogy existing between several of the specific forms and their representatives from other well determined tertiary (eocene) deposits.[1]

[1] The eocene age of the Tejon rocks is maintained by Prof. Jules Marcou (Report of the Chief of Engineers, Washington, 1876, p. 387), who made a personal examination of the region. "I was not able to find a single cretaceous fossil, nor even any true cretaceous generic forms, in the entire formation; and I am altogether of the opinion expressed by Mr. Conrad, many years before Mr. Gabb, in volume 5, of Pacific Railroad Explorations, pages 318, 320, *et. seq.*, who, judging from certain fossils found in an isolated block, at the entrance of the Cañada de las Uvas, has very judiciously referred these rocks to the eocene-tertiary formation" . . . . "The fauna of Tejon reminds one very much of the fauna of the sands of Anvers [?], near Pontoise, and of the sands of Gre[*i*, ?]gnon, near Versailles."